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PREPARING FOR AND DEFEATING BLACK SWANS

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1 In the Dreamtime ...

In the stories from the Dreamtime of the Nyungar people of south west Australia, all swans were once white.

- Two white swans offended the eagles.
- As punishment, the eagles plucked out the swans' white feathers and left the birds to die in the desert. The blood stained their bills red.
- The crows felt sorry for them, so they plucked out some of their own black feathers and gave them to the swans.
- Since that day, swans have black feathers and red bills. And red and white flowers grow in the desert, the swans' white feathers painted with their blood ...

<http://www.nyungar.com.au/tours.html>

Once upon a time all swans were white, and every day the swans would look into the reflection of themselves and say, 'aren't we beautiful birds, look at us, no one is as beautiful as we are.' The Eagle (*Walij*) was always sitting in the tree and got sick of the swans bragging about their beauty, he flew down out of tree and plucked all of the white feathers from the swans except some white feathers on the wings and then flew back to his tree. As winter approached and it became cold the swans began to shiver and cry for warmth. The *Wardung* (black crow) flew down and plucked some feathers from his back and stuck them onto the back of the swan. The swan began to cry and he did not know that his wing was bleeding and as he wiped his nose the blood rubbed all over his beak and that is why it is red today. If you look closely at the feathers and his back it looks as if they are stuck, as they are always ruffled.

http://www.austourism.com.au/aboriginal_art/pages/swan.htm

In the days of Dreamtime, all Swans were white. During that time, two Swans rested on a lagoon, but they soon found the lagoon was the home of the Eagle Hawks.

The Eagle Hawks resented their intrusion, and attacked the Swans, beating them severely before picking them up and carrying them with their sharp strong claws far south.

Finally they dropped the Swans on rocks near a stony dessert continually beating them and plucking out all of their feathers.

There, naked and almost dead, the Swans heard the call of the black Crows. They looked up and saw hundreds of them. The Crows called out in their strange croaking voices 'The Eagles are our enemies too, but we won't let you die. We will send you via the wind some of our feathers to keep you warm.'

So the Swans, having all their feathers plucked with blood running over their white feathers, clad themselves with the black feathers.

And ever since that day red and white flowers grew up in the dessert from the Swans' plucked feathers painted with blood. And the Australian Swan now comes in two colours, not just all white but black as well.

<http://www.ccentre.wa.gov.au/175thAnniversary/BriefHistory/Pages/Default.aspx>

In Aboriginal Dreaming, WA's black swan emblem was originally white. The story tells of two white swans that stole the boomerangs of eagles and, as punishment, the eagles plucked out the swans' white feathers and left the birds to die in the desert. The blood stained their bills red. Black crows, feeling sorry for the swans, plucked out their own feathers to disguise them so that the eagles would not threaten them again.

¹ Organised by Terrapinn Ltd (South Africa), who invited the author and sponsored his participation in the conference.

2 European Discovery



Black swans (*Cygnus atratus*) were first recorded by Europeans by Willem de Vlamingh's expedition in 1697. This picture from 1788-1792 is the earliest known picture of a black swan, published in 1792, from the First Fleet Artwork Collection at The Natural History Museum, London.²

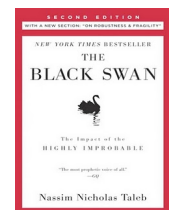
The discovery of black swans changed thinking in Europe. Until then, all swans had been thought to be white, and the 'risk' of a black swan went from zero to one.

What does this teach us? 'Improbable' is not the same as 'impossible,' and the absence of evidence is not the same as evidence of absence.

3 Taleb's Black Swans

Taleb's³ Black Swan (with capital letters) has three characteristics:

1. It is an outlier, outside the realm of regular expectations because nothing in the past can convincingly point to its possibility;
2. It carries an extreme impact;
3. In spite of its outlier status, we concoct explanations for its occurrence after the fact, making it explainable and predictable.



Taleb sees two worlds, Mediocristan, where randomness is structured and simple models work reasonably well, and Extremistan, where randomness is unstructured and simple models, particularly those that assume Gaussian or Normal distributions, are not appropriate. In this view, Black Swans live in the Fourth Quadrant in Table 1.

Table 1: Taleb's Fourth Quadrant

	Simple payoffs	Complex payoffs
Mediocristan Structured randomness, simple models work	First Quadrant Extremely Safe	Second Quadrant (Sort of) Safe
Extremistan Lack of structure to randomness	Third Quadrant Safe	Fourth Quadrant Black Swan Domain

4 Predicting Black Swans?

The Fourth Quadrant is an area where traditional models may not be a lot of use, and prediction becomes a difficult and often pointless activity.

The sinking of the RMS Titanic was a Black Swan at the time: outside the realm of expectations, with a large impact for those aboard, and explainable in hindsight. However in 1907, just five years before, Captain EJ Smith stated in an interview⁴:

When anyone asks me how I can best describe my experience in nearly forty years at sea, I merely say, uneventful ...

I have seen but one vessel in distress in all my years at sea. I never saw a wreck and never have been wrecked, nor was I ever in any predicament that threatened to end in disaster of any sort.

Taleb uses the example of the Thanksgiving turkey. For a long time it is looked after and fed well, and its prospects seem excellent ... right up until the day before Thanksgiving! Here, the same data

² Picture reference: http://en.wikipedia.org/wiki/File:Cygnus_atratus_%22Mulgo%22.jpeg.
<http://www.ccentre.wa.gov.au/175thAnniversary/BriefHistory/Pages/Default.aspx>.

³ Nassim Nicholas Taleb, 'The Black Swan: The Impact of the Highly Improbable,' Second Edition, Random House New York, 2010.

⁴ <http://www.titanic-lore.info/Capt-Smith.htm>. The Titanic struck an iceberg at 23:40 on 14 April 1912, and sank at 02:20 on 15 April (<http://en.wikipedia.org/wiki/Titanic>).

can confirm a theory, and also confirm its opposite – if you survive until tomorrow, it could mean that you're immortal, or just shorter of breath and one day closer to death.⁵

Here are some other examples of our lack of forecasting ability. Figure 1 shows the wide spread of forecasts of the NYSE composite index based on 'standard' log-normal random walks with historical parameters. Figure 2 shows one-year forecasts for setting budget estimates for North Sea tax revenues, but they are badly wrong; for each budget the estimate was revised upwards compared to the pre-budget estimate, but not enough.

Figure 1: Forecasts of the NYSE Composite Index⁶

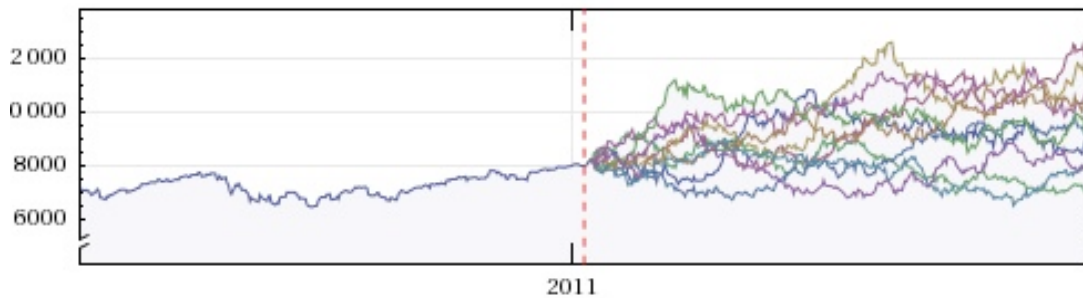
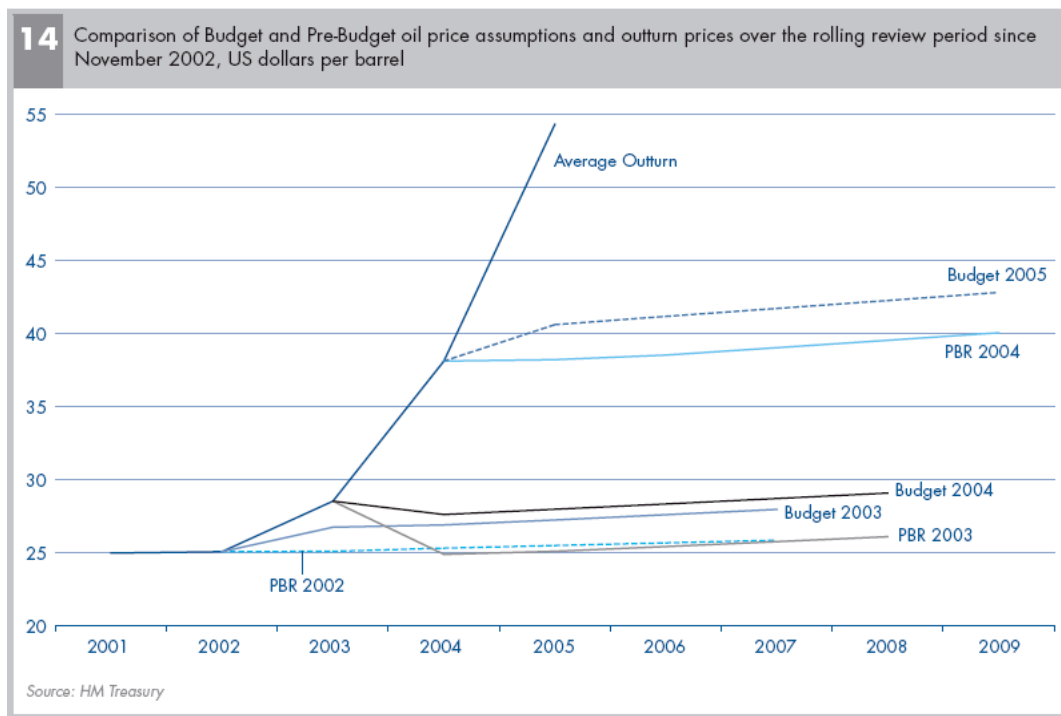


Figure 2: UK Treasury forecasts of North Sea tax revenues⁷

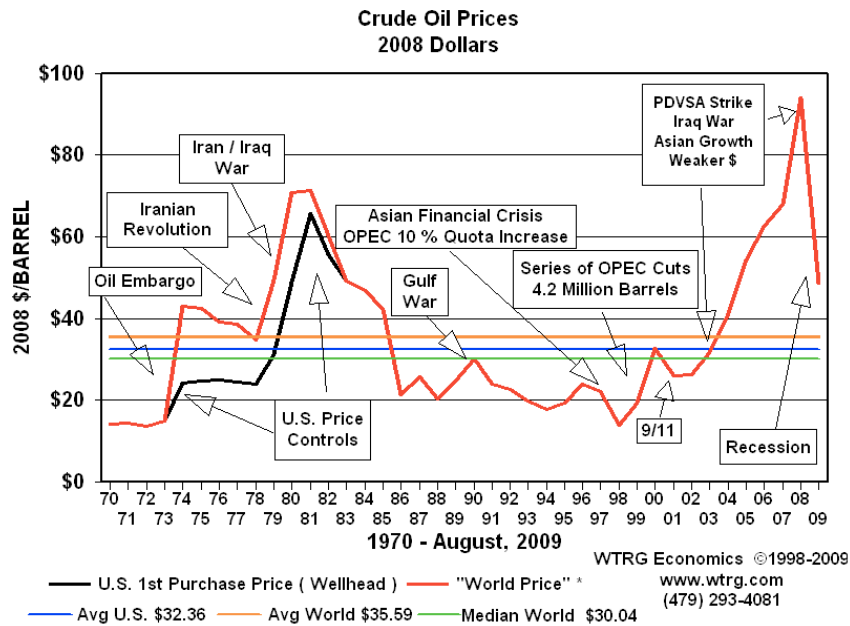


Look at Figure 3 and the events that may have influenced crude oil prices. Some of these events might be thought of as Black Swans. Does it seem reasonable to attempt to forecast crude prices on the basis of what has been observed in the past?

⁵ Pink Floyd (Mason, Waters, Wright, Gilmor), 'Time' 'So you run and you run to catch up with the sun but it's sinking, Racing around to come up behind you again. The sun is the same in a relative way but you're older, Shorter of breath and one day closer to death.' <http://www.pink-floyd-lyrics.com/html/time-dark-lyrics.html>.

⁶ <http://www.wolframalpha.com/input/?i=NYSE+index>; accessed 18 January 2011.

⁷ http://www.hm-treasury.gov.uk/media/0/3/pbr05_nao_508.pdf.

Figure 3: Crude oil prices⁸

The answer is not likely to lie in more sophisticated forecasting. In an extensive empirical test of forecasting accuracy, Makridakis and Hibon⁹ concluded that:

1. Statistically sophisticated or complex methods did not provide more accurate forecasts than simpler ones;
2. The relative ranking of the performance of the various methods varied according to the accuracy measure being used;
3. The accuracy of combining various methods outperformed, on average, the individual methods used;
4. The accuracy of the different methods depended upon the length of the forecasting horizon involved.

Black Swans have 'fat tails!' In the realm of Black Swans, events occur that are many standard deviations from the mean when using standard Gaussian models. Value at Risk and similar models don't work well for rare events at the extremes of the range: the failure of firms like Long Term Capital Management (LTCM) illustrates the limitations of conventional models in the finance sector.¹⁰

There is an important lesson here: if we have no evidence, we can't always rely on assumptions and models – there is no reliable way of computing small probabilities.

5 A Power Transmission Example

A few years ago we advised TransPower, the New Zealand electricity distribution company, on high-impact-low-probability (HILP) events associated with the North Auckland and Northland grid upgrade proposal. We started by exploring models of HILP grid failure events, but concluded that there was too much model uncertainty for this to be a justifiable approach, and we took a different direction.¹¹

⁸ WTRG Economics, <http://www.wtrg.com/prices.htm>. Image: http://www.wtrg.com/oil_graphs/oilprice1970.gif. PDVSA strike: Venezuelan general strike, 2002-03, http://en.wikipedia.org/wiki/Venezuelan_general_strike_of_2002-2003.

⁹ Spyros Makridakis and Michele Hibon, 'The M3-Competition: results, conclusions and implications,' Int J Forecasting 16 (2000) 451-476. <http://www.forecastingprinciples.com/files/pdf/Makridakia-The%20M3%20Competition.pdf>.

¹⁰ The hedge fund LTCM failed, in part, because mathematical models failed to anticipate changes in forecast correlations in emerging markets when market liquidity reduced, exacerbated by high leverage, despite Nobel Prize winners Merton and Scholes and other high profile traders in its team. For a short summary see <http://en.wikipedia.org/wiki/LCTM>, or Roger Lowenstein (2000), 'When Genius Failed: The Rise and Fall of Long-Term Capital Management,' Random House New York, for a fuller account.

¹¹ <http://www.ea.govt.nz/document/7011/download/industry/ec-archive/grid-investment-archive/gup/2007-gup/north-auckland-and-northland-proposal-history/>, <http://www.ea.govt.nz/document/7018/download/industry/ec-archive/grid-investment-archive/gup/2007-gup/north-auckland-and-northland-proposal-history/>.

Some of the problems are illustrated in the following diagrams, taken from papers by Ancell, Edwards and Krichtal.¹² Figure 4 shows the frequency of blackouts following a power law distribution, in which the probability of a blackout is related to its magnitude by some constant exponent. However, there were no extreme events in the 14 years over which this data was collected, and the blue part of the graph, which is the area of interest in this case, must be extrapolated. The mean of the distribution is influenced significantly by whether extreme events are in the data set, and by the distribution shape assumptions that underlie the statistical analysis (Figure 5). As Ancell and colleagues say, ‘in analysing the impact of blackouts, the tail does wag the dog!’

Figure 4: Example of a distribution of blackout size in New Zealand

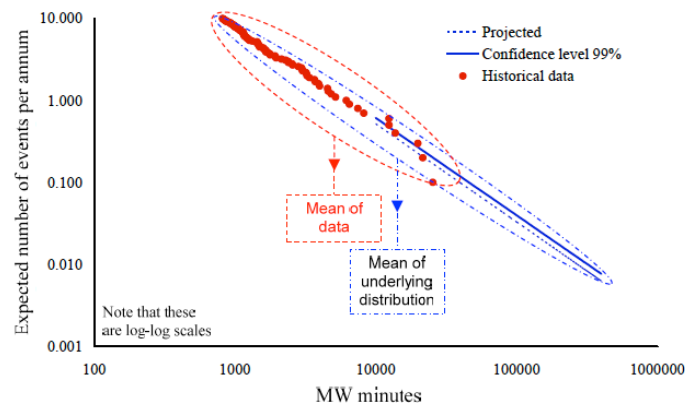
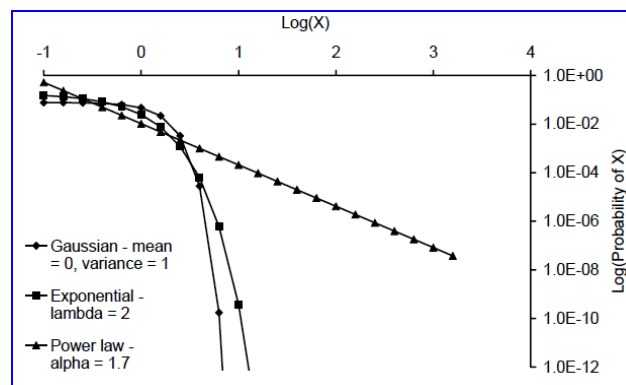


Figure 5: Distribution shape assumptions



6 Making (More Reliable) Forecasts?

Forecasting when the tails are important is very hard:

- Data is sparse, and we may need to use data from other areas or time periods that may not be very similar to the one being considered;
- There is no or very little guidance on the 'best' model for the existing data, leading to widely divergent predictions for events beyond the observed range;
- Even in areas where we have a lot of experience, people are very poor at predicting.

On top of all this, in some domains the business environment may not be constant, so the distribution shapes and parameters may not remain the same even if you could estimate them – the past may not be a reliable guide to the future. (At least part of the failure of LTCM may be attributed to changes in the correlations between financial instruments as liquidity disappeared; this might be thought about as related to an inadequate model, or the model changing as other events unfolded.)

¹² Ancell, G, Edwards, C and Krichtal, V, ‘Is a Large Scale Blackout of the New Zealand Power System Inevitable?’ 2005 EEA Conference paper; Ancell, G, Edwards, C and Krichtal, V, ‘Allowing for Extreme Events in Transmission Planning,’ 2006 EEA Conference paper.

This is what Lo and Mueller¹³ call partially reducible uncertainty, where:

we are in a casino that may or may not be honest, and the rules tend to change from time to time without notice. In this situation, classical statistics may not be as useful as a Bayesian perspective, in which probabilities are no longer tied to relative frequencies of repeated trials, but now represent degrees of belief.

Warren Buffet's warning¹⁴ applies here: 'Beware of geeks .. bearing formulas.'

In practice, we need to simplify the information streams that impinge on us, but that leads to biased judgement. In summary:

- The amount of information available is increasing, but information is costly to obtain, store and analyse, so we must summarise information to make sense of it.
- This introduces simplifications and removes randomness, thus we visualise the world as less random than it really is and we underestimate the outliers, the Black Swans.

In addition, the world is becoming more interesting: there is increasing complexity and inter-connectedness, which leads to increasing uncertainty, decreasing predictability and more frequent Black Swans.

7 Not All Rare Events are Black Swans

We've all heard Donald Rumsfeld's quote:¹⁵

Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tend to be the difficult ones.

Black Swans are the unknown unknowns. There are many Grey Swans, the known unknowns that are rare and often have very large impacts, but are quite different from the Black Swans that catch us by surprise in that we have experienced them or we can envisage them and their effects. Some examples:

- Extreme natural events (major earthquake, volcanic eruption, tsunami, extreme storm like Katrina);
- Oil well blowout;
- Stock market crash (might be difficult to model, but not a Black Swan).

The Global Financial Crisis was not a Black Swan. Similar events have occurred in the recent past – think of the US bank failures in the early 1980s, the US Savings and Loan crisis in 1982, the failure of LTCM in 1998, and so on. What did we learn from these events? Apparently not much that was effective, so they will probably happen again. As Taleb puts it, 'You know with near certainty that a plane flown by an incompetent pilot will eventually crash.'

It is clear that many commentators have not read Taleb's book, or have not understood it.

8 How Should We Deal with Black Swans?

There are a few simple rules for dealing with Black Swans (and some more complicated ones later):

- Black Swans are unpredictable, so we need to accept their existence and manage accordingly.
- We should distinguish between positive and negative contingencies, and put ourselves in situations where favourable consequences are much larger than unfavourable ones.

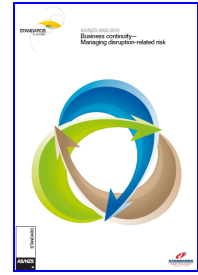
¹³ Lo, A and M Mueller, 2010, 'WARNING: Physics Envy May Be Hazardous To Your Wealth,' J. Investment Management 8, 13-63.

¹⁴ Warren Buffet, interview with Charlie Rose, 1 October 2008, <http://www.charlierose.com/view/interview/9284>

¹⁵ <http://www.defense.gov/transcripts/transcript.aspx?transcriptid=2636>

Accept Black Swans exist: become resilient and recover quickly. There are Standards¹⁶ that may help here, and some simple guidelines:

- Don't focus on models, but concentrate on errors and their consequences, and on developing robustness to those errors: invest in preparedness rather than prediction;
- Aim for small and diverse rather than large and monolithic, and simplify connectedness;
- Develop redundancy: anything with a secondary use presents an extra opportunity;
- Beware of debt: leverage makes you more vulnerable to forecast errors;
- Insurance cover may not be sufficient to cope with a genuine catastrophe.



We had an example of a physical Black Swan last year.¹⁷ The Icelandic volcano Eyjafjallajökull erupted on 20 March 2010 and an ash cloud was released on 14 April. Most of Europe's airspace was closed from 15-20 April, and there was huge disruption (and loss) across the world. However, there were some interesting examples of resilience:

- UPS redirected freight to Istanbul and delivered to Europe by truck;
- Tesco's African produce was landed in Spain and transferred to lorries for onward travel.

Successful organisations plan for disruption, even from Black Swans. One approach is to focus on the impacts that might arise, irrespective of the initiating Black Swan events, and explore options for returning to 'business as usual.'

- Brainstorming workshop is a good forum for generating a diversity of ideas and options.
- Participants must suspend disbelief, and ask 'What if ...?' without thinking too much about the likelihood of specific initiating events or even of the consequences being examined.
- It is then possible to develop ways of dealing with the outcomes, and build them into the thinking process of the organisation.
- Finally, the options can be examined and rated in terms of their cost-effectiveness under normal and abnormal conditions.



Maximise exposure to positive Black Swans – some of them may be white!¹⁸ Some people and organisations are good at recognising and exploiting good luck; venture capitalists and entrepreneurs are particularly good at this. With little to lose and much to gain from a rare event, there is often a disproportionate payoff from the unknown.

In the context of financial model risk, Lo and Mueller¹³ discuss:

- Stop-loss policies, to incorporate the risk of ruin or franchise risk;
- Limits on capital commitments and positions, to prevent 'outlier' signals from making unusually large or concentrated bets;
- Statistical regime-switching models, to capture changes in the profitability of the strategy;
- Bayesian decision rules, to trade off making a bet when the signal is wrong against not making a bet when the signal is right.

Taleb outlines a 'barbell strategy' for financial investment, a convex portfolio with average risk, containing a large proportion in safe investments like Treasuries and the remainder in many highly speculative, leveraged bets with high upside. Figure 6 shows the returns from a commercial investment product with some of the characteristics of a convex portfolio: a proportion of invested funds are used to purchase a zero-coupon bond that guarantees a return of capital at maturity (with credit-enhanced guarantees of repayment), the balance in leveraged and speculative investments

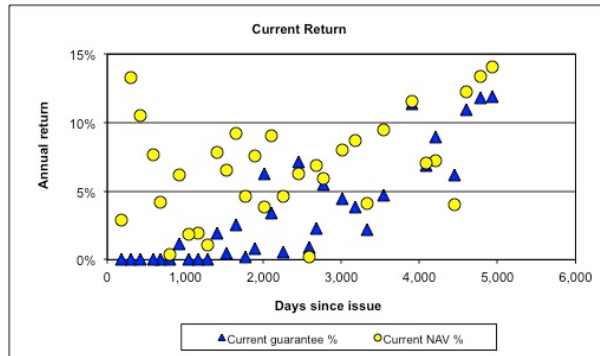
¹⁶ AS/NZS 5050:2010 Business continuity - Managing disruption-related risk.

¹⁷ http://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallajökull
http://www.iso.org/iso/iso-focus-plus_index/iso-focus-plus_online-bonus-articles/isofocusplus_bonus_iso31000-icelandic-volcano-crisis.htm
[http://www.ros-group.com/rosgroup/en/urs.nsf/vwEmbedNewslettersByKey/2010-04/\\$FILE/201004%20URS%20Newsletter.pdf](http://www.ros-group.com/rosgroup/en/urs.nsf/vwEmbedNewslettersByKey/2010-04/$FILE/201004%20URS%20Newsletter.pdf).

¹⁸ Coat of arms of Canberra, http://en.wikipedia.org/wiki/Coat_of_arms_of_Canberra, image at http://en.wikipedia.org/wiki/File:Canberra_COA.gif. The supporters are the Australian black swan, representing the Australian Aborigines, and the European white swan, representing the white settlers.

(although probably not as speculative as Taleb might recommend), and a credit-enhanced rising guarantee where a proportion of profits are invested in further zero-coupon bonds.¹⁹

Figure 6: Commercial quasi-barbell investment product



9 Black Swans in South Africa?

The conference organisers asked me to comment on Black Swans in South Africa. That’s a tall order, because Black Swans can’t be predicted (otherwise they wouldn’t be Black Swans!).

However, I’ve stuck my neck out to list in Table 2 some of the things that just might be considered if you were to conduct a resilience brainstorming exercise of the kind outlined in the previous section. They are definitely not predictions, and they’re probably Grey Swans rather than Black Swans, but they might spark some ideas if you want to think about and perhaps plan for doomsday scenarios.

Table 2: Grey Swans in South Africa

Concern	Event	Impacts
Eskom Keoberg Power Station	Major radioactive release, with a NW wind	Catastrophic effects on Cape Town and surrounds
South African power supply	Long-term catastrophic failure of a major power station	Widespread load shedding, major disruption to society, industry and mines
Government and ANC incompetence and corruption	Social division, widespread civil unrest	Imposition of emergency measures or martial law Army coup
Government finances collapse, or policy captured by the far left	Expropriation of private resources (e.g. mines, farms)	Exit of foreign direct investment, economic collapse

I have one final comment. Apparently against all expectations, between 1990 and 1994 South Africa made an orderly transition to a vibrant, diverse democracy. As an outsider, it is my opinion that South Africa has already seen one of the most significant Black Swans of the last hundred years, and it was one with immense positive impacts.

¹⁹ Man funds with rising guarantees http://www.maninvestments.com.au/files/default/file/man/ManOMIP_FundPrices_Monthly.pdf; current returns at 4 Feb 2011, guarantees and net asset values (NAV) at 31 Dec 2010.